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A LARGE BRACHYURAN-LIKE LARVA OF THE HIPPIDAE (CRUSTACEA: DECAPODA: ANOMURA) FROM THE BANDA SEA, INDONESIA: THE LARGEST KNOWN ZOEA

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Abstract.—A collection of planktonic Crustacea from the Banda Sea, Indonesia, contained several specimens of a large, late stage zoea belonging to the anomuran family Hippidae. As is true for the few previous descriptions of hippid larvae, the zoea bears a remarkable (but superficial) similarity to larvae of true crabs (Brachyura) in that the carapace is spherical and the lateral and rostral spines are distinctly deflected ventrally. The zoea is also remarkable in its size; the width across the lateral carapace spines is over 12.0 mm, making this the largest known zoea of the Anomura or Brachyura. Characters of the zoea are compared to previous descriptions of hippid larvae.

Planktonic larval stages of the decapod crustacean infraorders Brachyura and Anomura are usually easy to distinguish. The two most obvious characters concern the carapace: in anomurans the carapace is longer than broad, and the rostral spine is directed anteriorly, whereas in brachyuran larvae the carapace is spherical and the rostral spine (usually present) is directed ventrally (see Williamson 1982). Another differentiating character is that the sixth abdominal segment, in later stages, always bears setose uropods in the Anomura, whereas uropods are absent in zoeal stages of the Brachyura (except for raninids, homolids, and some other "primitive" crab families; Rice 1980, Martin 1991). Also, most anomuran larvae have a hair-like process between the first and third posterior spines on the telson, although this condition changes with ontogeny (Konishi 1989, Martin 1991).

The present paper describes a large zoeal stage of the anomuran superfamily Hippoidea. The zoea is of interest not only for its great size (over 6.0 mm carapace length, and over 12.0 mm in carapace width, including the lateral carapace spines), making it the largest known zoea in the Decapoda, but because, like previously described larvae of the Hippoidea, it is superficially similar to zoeal stages of the Brachyura.

Materials and Methods

Zooplankton samples were collected during an expedition of the R/V *Alpha Helix* to the area of the Banda Sea, Indonesia, in 1975. One lot contained 7 large, late stage zoeae that we herein assign to the anomuran family Hippidae; this lot was collected in the south Ceram Sea, just northwest of the island of Ceram (sometimes spelled Seram), at AH Station 19 (3°55.7′S, 128°07.7′E, trawl RMT-8, 0–150 m). An additional lot containing 4 specimens of this same zoeal stage was later found in collections from AH Station 28, also in the Ceram Sea (3°14.8′S, 127°38.0′E, trawl RMT-8, 0–100 m). Zooplankton was collected with an otter trawl fitted with a 0.5 mm mesh plankton net. Most of the crustacean samples from this expedition, including those with the hippid zoeae, dried out completely before they came to our attention (early 1989). Some of the larvae were rehydrated in Trisodium Phos-

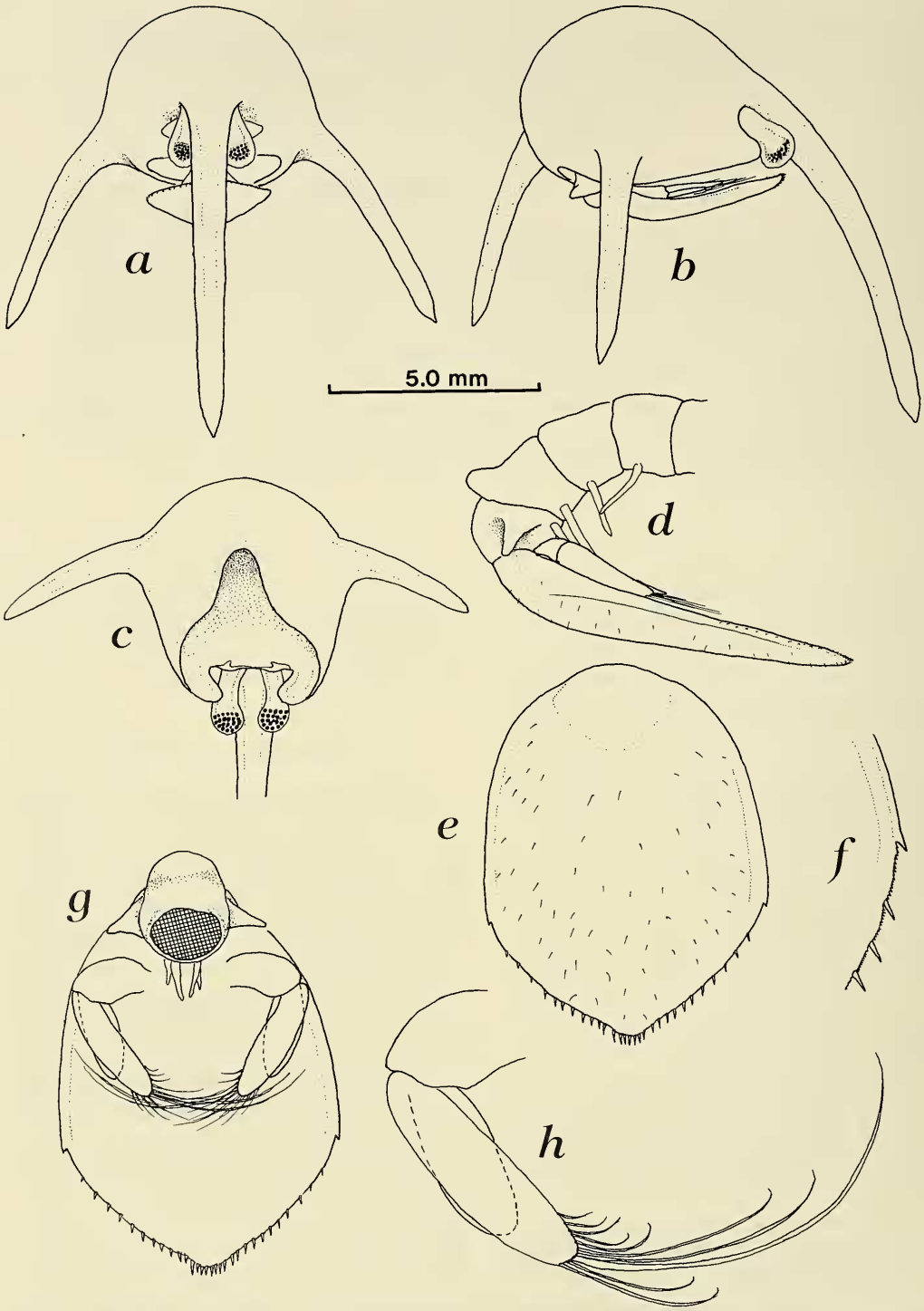

Fig. 1. Large hippid zoea from the Banda Sea, Indonesia: carapace, abdomen, and telson. a, entire zoea, frontal view; b, same, side view; c, ventral view of carapace and spines with telson and abdomen removed (note how ventral carapace is shaped to conform to opercular-like telson; d, lateral view of abdomen and telson; e,

phate for a period of 48 hours and then transferred to 70% ethanol. A few of the larvae were left dry. All drawings were made with a Wild M5APO dissecting microscope and a Zeiss compound stereoscope, each with camera lucida, from specimens collected at AH Station 19. Measurements were made from the single largest zoea, which was among the four specimens taken at AH Station 28.

Description

Size.—Carapace length 6.5 mm (from orbit to posterior border of carapace, allowing for slight curvature); carapace width (excluding lateral spines) 6.3 mm; length of rostral spine 10.8 mm; length of lateral spine 6.8 mm; distance from tip to tip of lateral spines 12.3 mm.

Stage.—Because of the large size and the development of the pleopods and uropods, this is probably a late stage zoea, equivalent to a stage 4 or later larva as compared to earlier accounts of development in the Hippidae (e.g., Hanson 1969).

Carapace (Fig. 1a, b, c).—Cephalothorax smooth, weakly calcified, globose, with extremely long downcurved rostral spine (longer than carapace length) and slightly downcurved lateral spines (less than rostral length). No dorsal spine noted in this stage.

Abdomen (Fig. 1d, g).—Five articulating somites, with the sixth fused to the telson. Somites 2 through 5 with pleopods. Somite length and width roughly equal. Fifth somite with blunt ventrolateral protrusions extending slightly posteriorly. Abdomen tightly flexed forward, with telson expanded and covering pereiopods and mouthparts ventrally.

Telson (Fig. 1e, f, g).—Longer than broad, terminally subtriangular. Dorsal surface with scattered short setae. Posterior border with sharp spines separated by minute serrations; spines becoming more dense approaching posterior terminus of telson. One immovable tooth (Fig. 1f) on either side of lateral border at about two thirds length of telson.

Uropods (Fig. 1g, h).—Long, extending approximately half length of telson (more than half if extended fully or if setation considered), biramous, outer ramus bearing 8–10 long simple setae, inner ramus unarmed.

First antenna (*antennule*) (Fig. 2a).—Stout, distal portion with 5 tiers containing aesthetascs.

Second antenna (Fig. 2b).—Protopod with three paired, evenly spaced spines, becoming progressively shorter distally; terminus of protopod spine-like; single spine located at articulation of endopod. Endopod extending nearly to tip of protopod, with three spines, tapering to acute distal tip; total length of endopod approximately ⅛ length of protopod.

Mandible (Fig. 2c).—Anterior border with 1 sharp and 1 blunt tooth, both of which exceed length of denticle row. Denticles acute, sclerotized, subequal in length, numbering 7–8.

Maxillule (Fig. 2d).—Endopod consisting of a single segment with 1 long, minutely serrulate, terminal seta. Exopod bilobed; basal endite with 3 stout serrate spines on distal margin; coxal endite with 1 short proximal seta, and 4 longer minutely serrulate setae distally, 3 of which are in distal group.

Maxilla (Fig. 2e).—Endopod with two simple and two plumose setae on margin plus one long simple seta on distal terminus. Endite not seen. Scaphognathite with numerous plumose setae spaced as illustrated.

Maxilliped 1 (Fig. 2f).—Basis bearing 5–7 plumose setae usually arranged in pairs;

←

dorsal (functional ventral) surface of telson showing indistinct fusion of telson with 6th abdominal somite (light stippling); f, higher magnification of lateral tooth and spines on right side of figure e; g, ventral surface of telson with uropods and abdominal somites 5 and 6 in place (stippled area denotes removed abdominal somite); h, right uropod. Scale bar corresponds to figures a–c only.

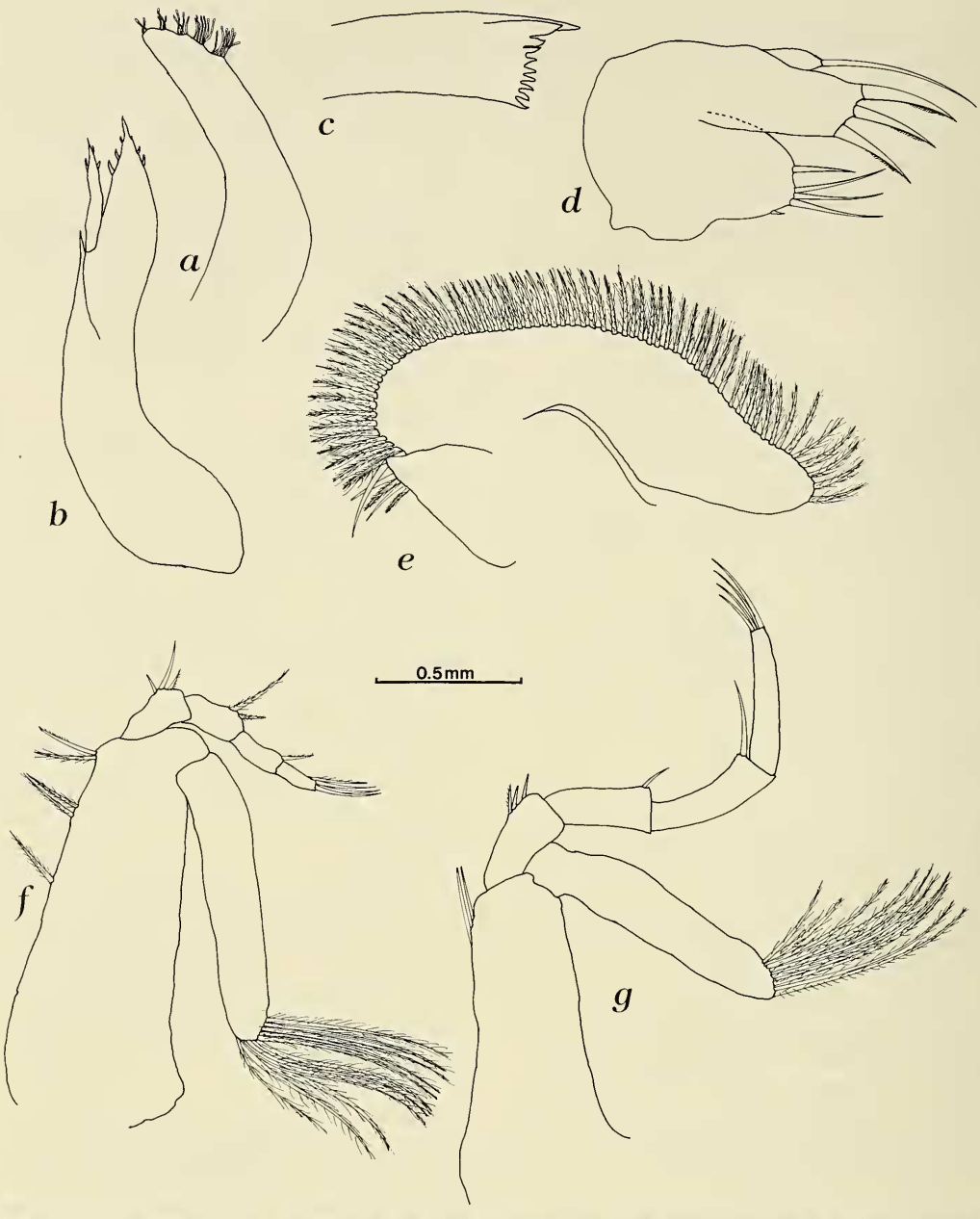

Fig. 2. Large hippid zoea from the Banda Sea, Indonesia: antennae and mouthparts. a, first antenna; b, second antenna; c, inner view of left mandible; d, maxillule; e, maxilla; f, first maxilliped; g, second maxilliped. Scale bar applies to all figures.

endopod 4-segmented, with setation 3, 2, 1, 4 (proximal to distal). Exopod uniramous with 10–12 natatory setae distally.

Maxilliped 2 (Fig. 2g).—Basis with two plumose setae; endopod 4-segmented, setation 3, 1, 1, 4 (proximal to distal); exopod with 9 to 11 natatory setae.

Maxilliped 3.—Present only as small undeveloped bud.

Pleopods (Fig. 1d).—Well developed, ex-

tending from somites 2 through 5, uniramous.

Discussion

The Banda Sea zoea is probably a late stage larva. The large size, coupled with the well developed pleopods and uropods, indicate to us that this zoea is at least in stage 4 or higher, if development proceeds as in other genera of the Hippoidea (e.g., Hanson 1969).

Of the two families, Albuneidae and Hippidae, that comprise the anomuran superfamily Hippoidea, larvae are best known for the albuneids, with larval stages of at least four genera known (e.g., Johnson & Lewis 1942, Knight 1970, Sandifer & Van Engel 1972, Gore & Van Dover 1980, and Stuck & Truesdale 1986, for *Lepidopa*; Menon 1937, and Seridji 1988, for *Albunea*; Johnson & Lewis 1942, Boschi et al. 1968, and Knight 1968, for *Blepharipoda*; Konishi 1987, for *Lophomastix*). Seridji (1988:1299) presented a table comparing larval characteristics of the "three known genera of the Albuneidae." However, Seridji apparently was unaware of the genus *Lophomastix,* for which larvae of one species have been described (Konishi 1987), and the genera *Leucolepidopa, Paralbunea, Zygopa, Austrolepidopa,* and *Stemonopa* (see Efford & Haig 1968, Efford 1969, Haig 1974b, Serène 1979), for which no larvae have been described. The major distinguishing character separating hippid larvae and albuneid larvae, according to Seridji (1988), is that albuneids have uniramous pleopods in later zoeal stages. This distinction does not always hold true, as Stuck & Truesdale (1986) documented biramous pleopods (albeit minutely biramous) in a fourth stage zoea of an albuneid (*Lepidopa benedicti*). No known albuneid larva has uropods as distinctly biramous as in the zoea described herein. Additionally, all known albuneid larvae possess a distinctive rhomboid-shaped telson that is always wider than long and is posteriorly somewhat truncate. The first and third, or first and fourth, teeth on the posterior border of the telson are strong and well developed. In contrast, the telsons in hippid larvae tend to be terminally rounded, with only the first posterior process modified as a strong immovable tooth, like the telson of the larva described here. Our larvae clearly belong to the Hippidae rather than to the Albuneidae.

Assignment to Genus

Assignment to a particular hippid genus is more difficult. There are currently three accepted genera in the Hippidae: *Emerita* Scopoli, *Hippa* Fabricius, and *Mastigochirus* Miers (see Haig 1970). Larvae are known only for *Hippa* and *Emerita,* and the zoeal stages of species in these two genera are extremely similar. Hanson (1969), in the only description of a complete larval series of a species of *Hippa* (*H. cubensis* (De Saussure)), mentioned that larvae of the two genera differ only in that zoeae of *Emerita* bear fewer aesthetascs on the antennule, fewer spines on the telson, fewer setae on the scaphognathite border, and are generally smaller than zoeae of *Hippa.* Hanson's (1969) description was actually of larvae of *H. testudinaria* (Herbst), rather than *H. cubensis,* according to Haig (1970). Hanson's comparison with species of *Emerita* was based on the work of Menon (1933), Johnson & Lewis (1942), Rees (1959), and Knight (1967). The descriptions of Smith (1877) and Faxon (1879) of larvae of *Hippa* were actually of species in *Emerita.* Hanson (1969) also mentioned that "The antenna of *Emerita* develops a long flagellum in the fourth or fifth zoeal stage" that persists through the megalopa stage, whereas this flagellum "is entirely lacking in *Hippa*" (Hanson 1969:155), and he related the above morphological differences to differences in feeding modes between the two genera, species of *Hippa* being scavengers rather than filter feeders. Our zoea is closer to Hanson's description of larvae of *H. testudinaria* than to existing descriptions of *Emerita* larvae

(e.g., Knight 1967 for *E. rathbunae*). Consequently, we tentatively assign our large zoea to *Hippa.*

An additional character strengthening the assignment of the Band Sea larvae to *Hippa* is that in Hanson's description of *H. testudinaria* larvae there is a noticeable ventrolateral projection extending from the posterior border of the fifth abdominal somite, similar to the condition of the Banda Sea zoea. This is also seen in plankton-collected stages attributed to *Hippa* by Lebour (1959: fig. 17) and to a lesser extent in the figures of Al-Kholy (1959: figs. 40–48). We have not seen this character in descriptions of *Emerita* larvae. Our zoea differs from Hanson's (1969) description of the larvae of *H. testudinaria* mostly in size. Hanson's largest zoea, at stage VI, had a carapace length of only 3.87 mm, whereas the Banda Sea zoea has a CL of 6.5 mm, which is even larger than the megalopa stage of *H. testudinaria.* The two species also differ morphologically; the Banda Sea zoea has a more strongly curved rostral spine, paired spines on the second antenna, and a single (unpaired) ventral tooth on the distal mandible border (compare to Hanson's fig. 3a).

Because of the above-mentioned uncertainty concerning generic placement of our larvae, the geographic distribution of all hippid genera should be considered in trying to assign the Banda Sea larvae. The geographically closest species of *Emerita* would be *E. emeritus* (Linnaeus), which, according to Efford (1976), ranges from the west coast of India east to southern Sumatra. At least one species of *Mastigochirus, M. quadrilobatus* Miers, is known from western Australia and Queensland and westward into the central sector of the Indian Ocean (Haig 1974a, 1974b); the only other known species in the genus, *M. gracilis* (Stimpson), also inhabits the Indo-West Pacific (China Sea and Sri Lanka, Haig 1974a). *Hippa* is the largest of the three hippid genera and is represented in the tropical western Pacific by at least 10 species, three of which, *H. adactyla, H. pacifica,* and *H. celaeno,* are widely distributed in the Indian and Indo-West Pacific Oceans (Haig 1974a). Therefore, known geographic distributions of species in the three hippid genera would also suggest the probability that the zoea described herein belongs to *Hippa.*

We confirm, if our larvae and those of *H. testudinaria* are typical for the genus *Hippa,* and if our zoea does in fact belong to a species of *Hippa* rather than to *Mastigochirus,* that larval size is quite different between the genera *Hippa* and *Emerita.* Our zoea, with a carapace length of over 6.0 mm (excluding the rostral spine) and with a distance of over 12.0 mm between the tips of the lateral spines, exceeds that for any known larval stage, including the megalopal stages, of any species of *Emerita.* Indeed, this zoea is larger than any zoea, and even megalopa, of the Brachyura reported in the survey of Hines (1986). To the best of our knowledge, the zoea described in this paper, while smaller than some of the unusual larvae of palinurid and eryonoid lobsters, which have phyllosoma and eryoneichus larvae sometimes considered "zoeal" (e.g., Williamson 1969), is the largest known zoeal stage among the decapod Crustacea.

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